The Super Eagle

Manual Version 2.5

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Introduction

Comprehensive CDMA Tools

The enormous growth of cellular telephone service has precipitated issues of spectrum capacity. This has resulted in a battle between digital proponents for both TDMA and CDMA formats. One of the potential advantages of Code Division Multiple Access (CDMA) is greater capacity. Unfortunately, it is also the most difficult attribute to optimize if the system parameters and configuration are not correctly implemented. "Pilot pollution", caused by excessive overlap of coverage contours, can rob CDMA designs of capacity. From a practical point of view, placement of the base stations is dependent on tower space availability, and particularly at high PCS frequencies, very terrain dependent. With CDMA modulation, many RF carriers share the channel, and digital codes are used to separate the voices. Sometimes, too many codes radiate in one area or sector of a cell and cause interference because it reduces the ratio of signal to noise ratio, often referred to as Ec/lo (energy in a correlated bit to that of total RF channel energy). CDMA designers have designed a sophisticated system of power control into each mobile telephone to minimize such interference. But controlling the power from each mobile so they look the same when they are received at the base station is no simple trick. Just a 3 dB difference between one RF carrier and another (as received at the base station) reduces the system capacity by one-half!

Propagation Analysis of CDMA Signals

Modulated signals sharing the same RF channel have unique characteristics when signal reflections are encountered. These reflections cause unphased additions of data symbols which can cause bit errors. Unmodulated signal strength measurements (using narrow bandwidth stimulus signals such as CW) are often misleading because the carrier strength of the signal appears to be strong, but there is often poor BER (Bit Error Rate) performance. The reason for this poor coverage is likely multipath reflections, better known as time dispersion of the RF carrier. Time dispersion or delay spreading is induced by reception of two or more signals of the same origin, with some components arriving later because they traveled a longer path; causing reflections and scattering of the signal. These distortions must be considered when planning and optimizing high-rate digitally-modulated radio systems.

The rational for advanced measurement tools

In almost all cases, short-term fading is caused by the environment, where two or more copies of the originally authored signal arrive at the receiver, but at different times. These radio waves are then known as multipath waves, and when they combine at the antenna, vary widely in both phase and amplitude. There are generally three properties that affect the character of the RF waves that arrive at the antenna. They are distance, propagation time and bandwidth of the transmitted signal. The signal strength has been the most traditional measurement for quality of the link. In an ideal environment, it has a predictable relationship to distance, and has been used to determine overall coverage in analog communication system designs.

The adverse effects of multipath reception are:

(i) rapid variations in the received RF amplitude

(ii) some FM of the original signal caused by the Doppler shifts on more than one path

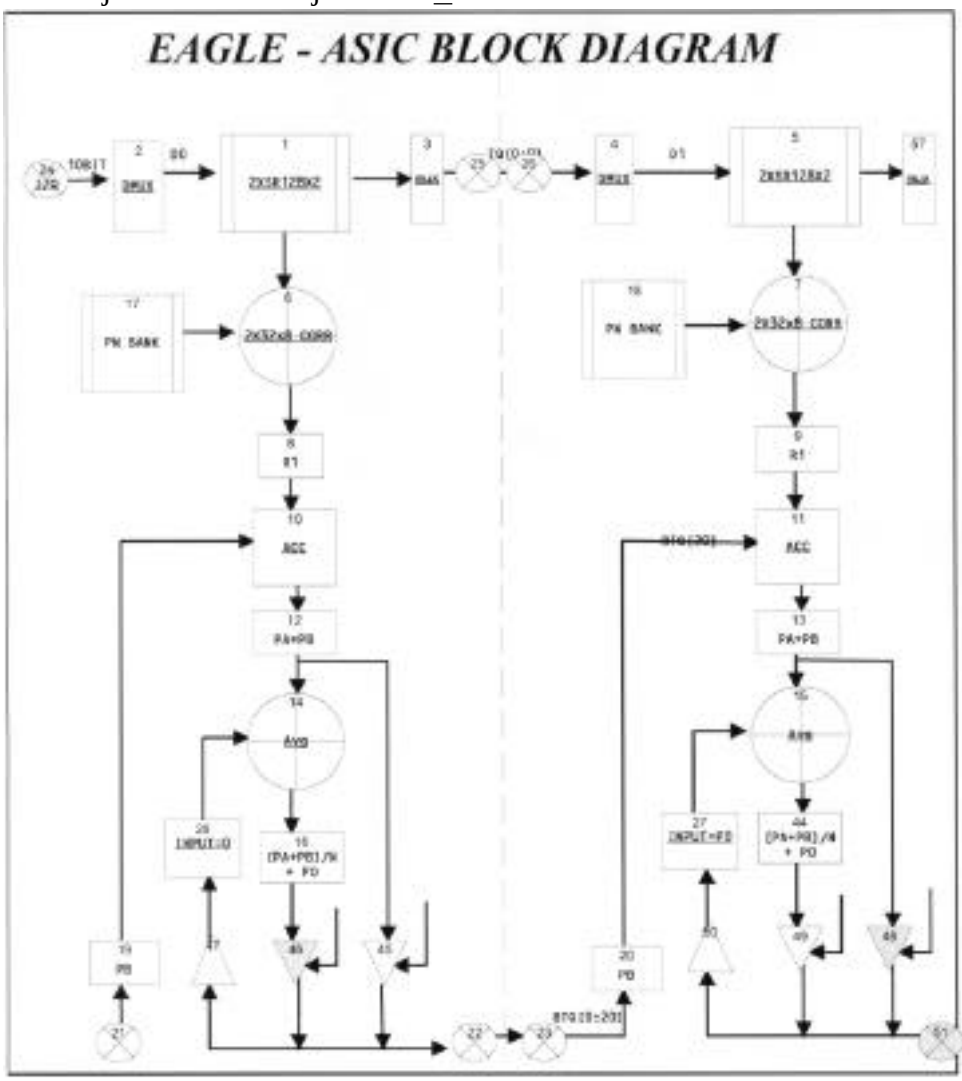
(iii) echoes (time dispersion) causing the carriers to add and subtract (vectorial in amplitude and phase) from each other causing data symbols to cancel

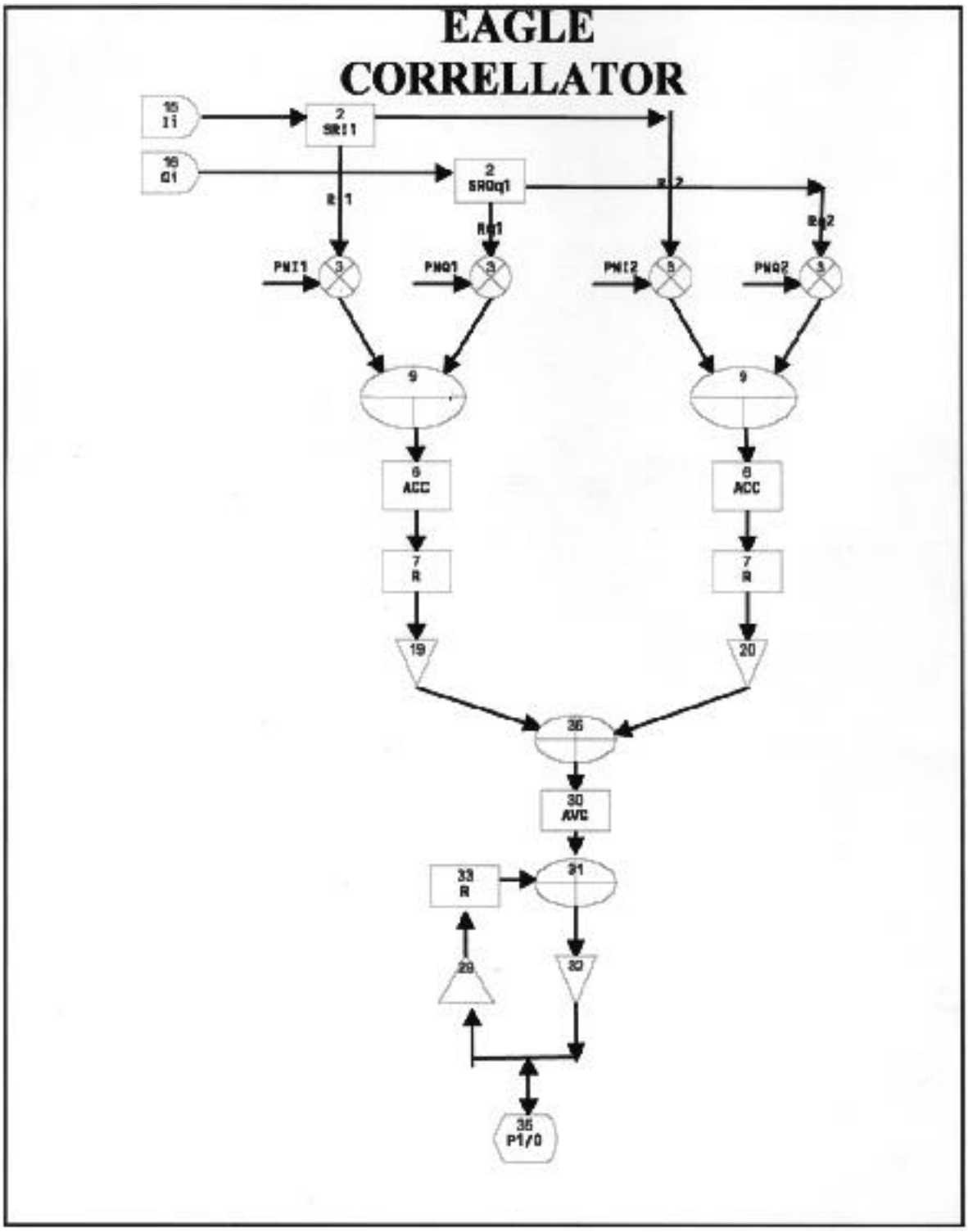
The BVS Super Super Eagle

The **Super Eagle** is a system-independent mobile measurement system which continuously surveys

all Cellular or PCS CDMA Pilot channel signals and reports their PN position and power profiles. Measured profiles indicate the distributions of interference and multipath components as a function of relative power and delay spread. The system employs a wide-band coherent (the clock and RF circuits of the Super Eagle are in-phase with the transmitter source by using the satellite as a common clock reference) receiver with an eight channel GPS system to synchronize and track the CDMA signals. The **Super Eagle** can be configured to survey continuously all or just specific base stations. The ability of the **Super Eagle** to scan all 512 base stations and the associated multipaths at each base station every frame 27 msec provides a fast "snap shot" of all the base stations for high-speed drive and fast fade analysis. The highly parallel, expandable time multiplexed architecture allows the **Super Eagle** to capture realtime co-channel interference and multipath analysis. The output of raw data from the **Super Eagle** is coupled to **Hawkeye** multipath fading analysis software. The standard equipment is configured to comply to IS-95/IS-97 and PCS JED008 standards.

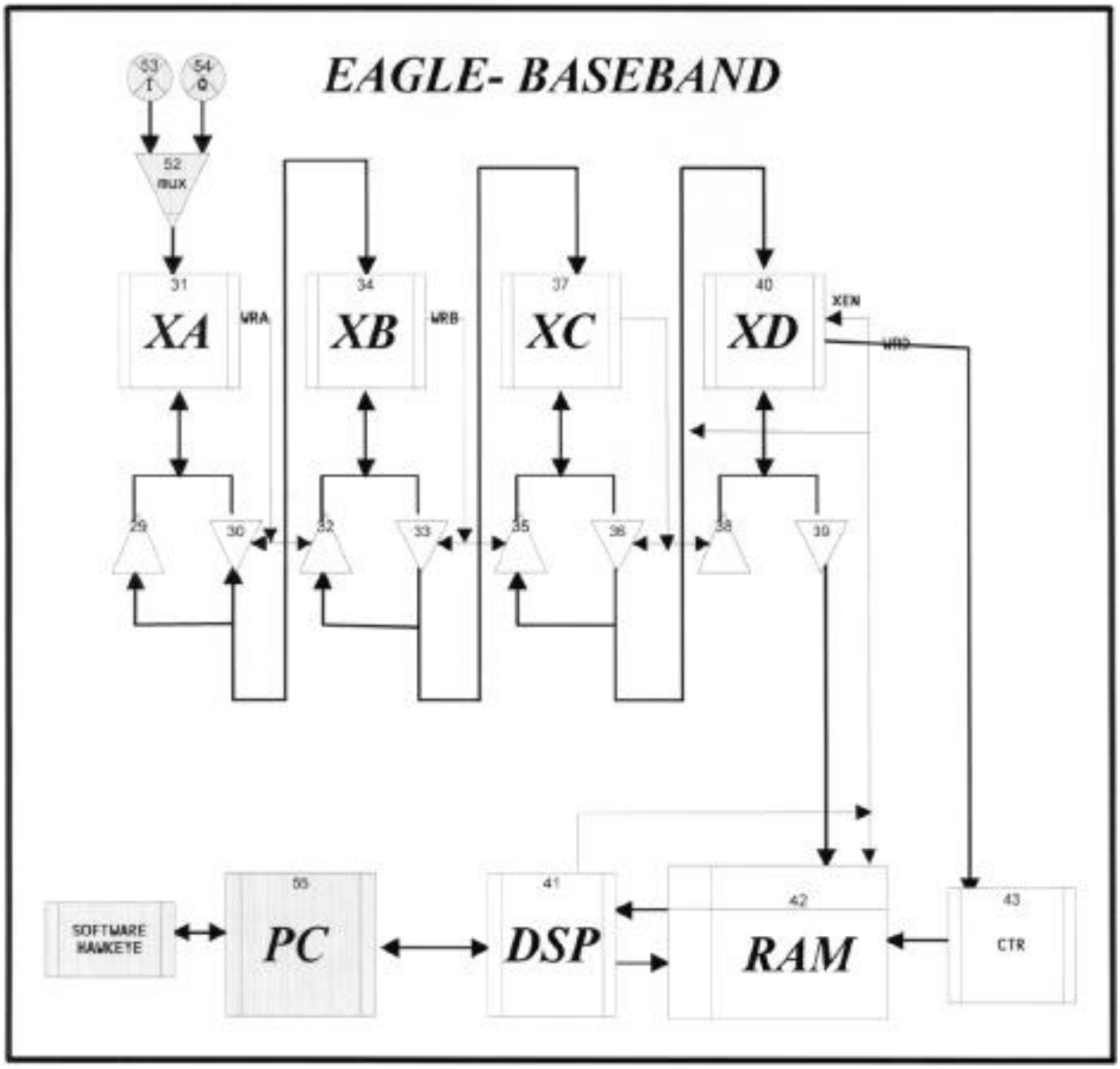
The main blocks of the **Super Eagle** are the 1.25 MHz wide RF receiver, digital correlator bank, GPS module, reference generator, DSP module and communication control processor. The figure shows the functional block diagram of all these salient elements of the hardware design. In addition to the CDMA wideband receiver, a narrowband, high selectivity RF receiver covers the Cellular or PCS frequencies and supports a 20 to 60 MHz tuning range. The receiver scans 15ms per channel and measures Received Signal Strength Indicator [RSSI]. The dynamic range of the receiver is -115 to -30 dBm with a 30 kHz bandwidth and better than -50 dB adjacent channel rejection at ±30 kHz.





At the front end of the correlator bank, the demodulated in-phase and quad phase baseband signals from the RF modules are sampled by 10 bit ADCs at 4 times the chip rate of 1.2288 MHz. The correlator consists of four banks of ASICs to compute correlation power in parallel with a chip resolution. Each bank consists of two ASICs implementing a bank of 512, 10 bit shift registers to store the last 512 phases of the input, a 512 bit shift register to store PN phases and seventeen 16 bit accumulators and three 32 bit accumulators to compute correlated power every chip period. The correlators are initially synchronized to GPS. The input samples to correlators are software selectable. Hence, by selecting the first sample for the

first chip bank and the third sample for second chip bank the correlation power resolution will be half chip. With optional add-on boards, resolution of the correlation power can be improved up to 1/4th of a chip. The Genlock board extracts the frequency reference for the correlator banks and time reference to DSP card from the 8 channel differential GPS. The DSP card consists of a high speed TI DSP (TMS 320C50 series with 30 nsec instruction time) and a dual UART to download power profile to the external device.



The DSP computes the optimum 256 PN phases and downloads to the PN shift register and continuously reads the correlation power from the ASICs and the timing reference from the genlock board. In a standard unit, the time tags and correlation power above a configurable threshold value are downloaded to a PC through an RS-232 port at up to 115 kbaud. The unit can be customized to interface to any external device for fast or synchronous download of raw data, without any threshold via its internal parallel port.

Super Super Eagle Data Logger

User Manual Version 4.0

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System Requirements

Computer: IBM PC compatible
CPU/Speed: Intel Pentium / 75MHz minimum
RAM: 24MB
Disk Space: 10MB required (not including log file space)
Operating System: Windows 95/98
Super Super Eagle interface: 1 free serial port between COM1: and COM4:

Introduction

The Super Super Eagle Data Logger (SEDL) is the PC interface to the Super Super Eagle. This applica collects data from the Super Super Eagle and displays the data. The SEDL also logs the data to binary The SEDL also controls which of the data is to be received; i.e., depending on the settings and options specified by the user.

The binary data files, that are created, may then be used as input into BVSs Chameleon application. T application formats and filters these data so that they may be used with a variety of popular post-processing packages such as MapInfo or MSI Planet.

SEDL is designed to take full advantage of all the Super Super Eagles many powerful features. These features (such as correlation length, sync reset delay, and clock source) greatly assist network plan and optimizers with their troubleshooting needs by adjusting the data collection depending on the net environment.

1. INSTALLATION

The installation of SEDL can be completed in a few minutes. Place diskette #1 in an available 3.5 dri your Windows task bar, click on START and then up to RUN. Choose SETUP.EXE from the drive that has selected (e.g., For the A: drive, type in A:\SETUP.EXE). After pressing OK, you will be taken through series of simple installation options. Select the options you wish to choose. After the installation pro has been completed, an icon will be created in the folder that has been specified. This icon will launc SEDL application.

Application Overview

SEDL was designed to allow users to display and log scan data with relative ease. Any number of child windows may be open at the same time (e.g. GPS Information and BIN Data screens). The most freque used controls are located in the control panel at the top of the application as shown in Figure 1. Othe options and settings may be accessed using the main menu. An additional status bar is provided at the of the main screen to provide important GPS and system status information.

The color of the control panel reflects the current synchronization status of the Super Super Eagle. the internal clocks and its GPS receiver are locked, the panel will be green. Otherwise, it will be re

Data received from the Super Super Eagle depends on the settings in the SEDL. The only constant in th system is that a record containing GPS position and timing information is sent from the Super Super once every second.

Quick Start

To begin scanning takes only three steps. By default, the BIN Data mode is checked and the BIN Data s is depressed. Choose the communications port to which the serial cable is connected. Press OK. Choos frequency or channel of the CDMA network in the area. Press ENTER. When the chosen frequency app the Current: column, the Super Super Eagle has been set correctly. Next, click on the START button. of all 512 base stations will appear on the display. Peaks represent pilot signals in the area. Change logging mode from Logging Off to Record Mode to begin saving the data being scanned.

2. CONTROL PANEL

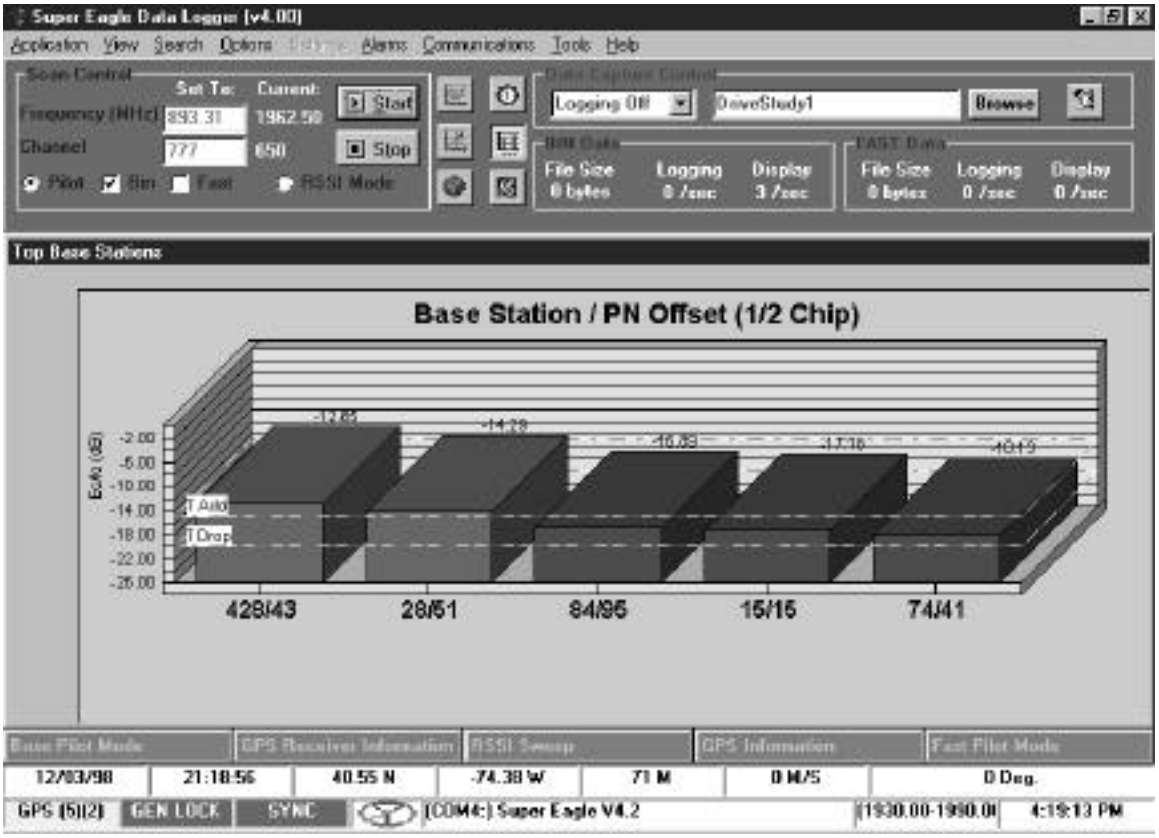


Figure 1

Scan Controls

The Scan Control group box on the left side of the control panel determines which scan modes have be activated and which frequency/channel will be monitored. The frequency may be set to any value wit range of the Super Super Eagle unit. If the frequency is not a valid channel, the nearest frequency w set. Also, the frequency may be set by adjusting the channel field. The frequency will automatically i the channel selected. The Current: values are those reported back from the unit.

One of two major modes may be selected; Pilot Signal or RSSI mode. If the Pilot Signal mode is selecte will be given the option to select a minor mode; BIN and/or FAST scanning. These modes will be discu later in the manual. The START and STOP buttons activate and deactivate the modes that are selected w radio buttons and checkboxes. For instance, if Pilot mode and FAST mode are selected, the START/STO buttons control FAST scanning.

Window Controls

The six buttons in the middle of the control panel pertain to various data windows. Clockwise from le these buttons are BIN Data ,FAST Data ,RSSI Data ,Top Base Stations, GPS Position and GPS Informati Clicking these buttons results in the particular child window being alternately maximized and minim

Data Capture Control

The data capture control group box in the upper-right corner of the control panel contains the optio logging. When the selection box reads Record Mode, any FAST or BIN data (being sent from the Super Eagle unit) will be logged to the filename in the next entry field. FAST data will have a .FAST extensio BIN data will have a .512 extension. A data marker may be placed in the file by selecting the button

the hand pointing. Markers can be used in the BVS Playback Utility to jump to certain spots of the da file(s).

BIN Data Status

The BIN data status group box reports back the current log file size, logging rate in records/sec, and display rate in records/sec.

FAST Data Status

The FAST data status group box reports back the current log file size, logging rate in records/sec, an display rate in records/sec.

3. MENU OPTIONS

Application Menu

The application menu contains three options, Open Configuration, Save Configuration, and Exit. The O and Save configuration options store and retrieve the current status of SEDL. Any options, frequencie will be saved in the filename specified for retrieval at a later time. The file, in which the configura stored, looks like a standard .INI file, but it may NOT be edited. Doing so could result in damaged configurations that cannot be recovered.

View Menu

The view menu is another way for the user to display the various scan screens available. The option checked if it is already visible. The option will be unchecked if the screen is not visible.

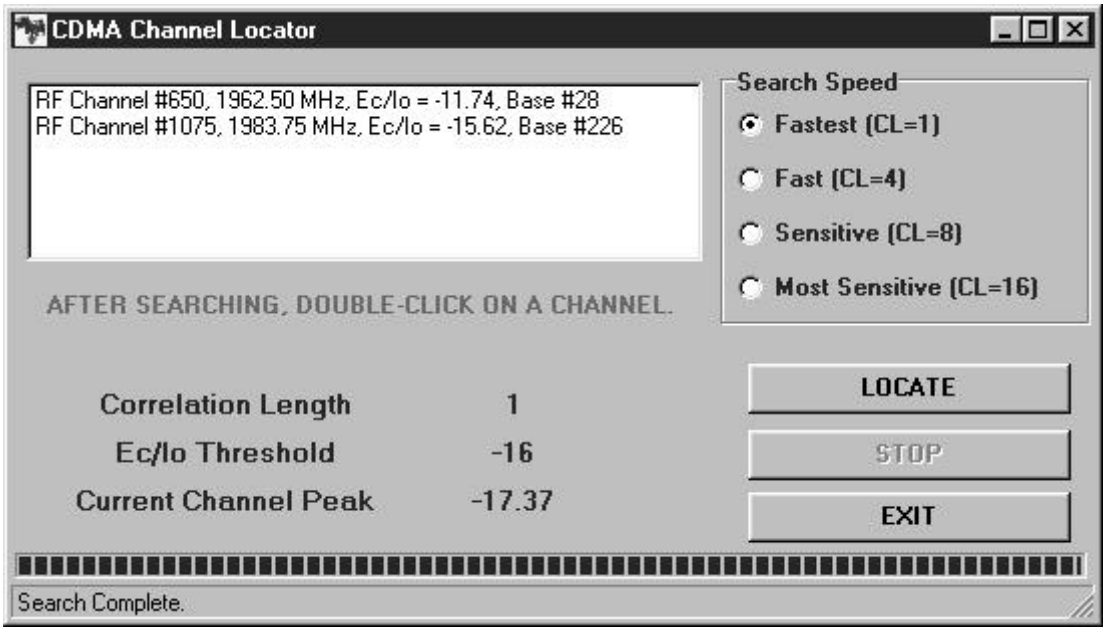


Figure 2

Search Menu

The search menu contains two options that aid in locating a particular network or base station. The f option is the RF Channel Locator. This option (as shown in Figure 2) performs a search for any chan that contains an Ec/Io ratio strong enough to suggest a CDMA network. A list of any such channels wi

appear in the list box on this screen. The user can then double-click on any entry and SEDL will set u appropriate frequency in the Scan Control group box.

The second option is Strongest Server. This will find the strongest base station at the given channel a up the appropriate display screen with the signal centered.

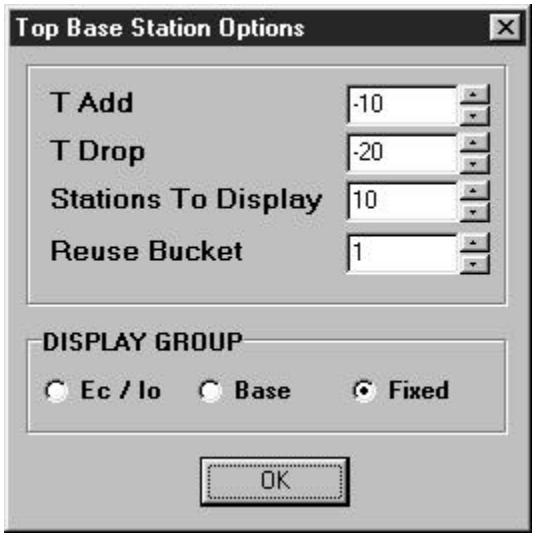


Figure 3

Options Menu

The options menu allows the user to place a new data marker in the log file as mentioned in the above control panel discussion. This menu also has an option for the Top Base Station screen (Figure 3). In option, the user may alter the number of base stations displayed, as well as the values for TAdd and T The Reuse factor may also be set. This factor colors any bar purple which is not divisible by the fact This is to alert the user to base stations not in the network reuse scheme.

The Top Base Station screen may also be ordered three different ways. Ordering by strongest Ec/Io v first. Next, ordering by base station number. Finally, a fixed ordering scheme keeps base stations in same location on the graph as when it first appeared. This fixed ordering scheme is good when focus i needed on one base station and having it jump through different locations quickly is not desired.

Settings Menu

The Settings menu has three separate options that can only be set while data retrieval is inactive. Th will be disabled if scanning is in progress.

The first option is sensitivity. This option tells the Super Super Eagle how many averages are to be performed during each scan. The choices are 1,4,8, and 16. The higher the number of averages, the h the resolution. The noise floor will drop and more base stations will become visible. Scan speed is sacrificed for this resolution. When there is a low number of averages, the speed is improved and the resolution is sacrificed.

Alarms Menu

There are two alarms that may be set. The first one alarms the user if the synchronization of all cloc been lost. The second one alarms the user if communication has been lost with the Super Super Eagle

Alarms may be set to be audible, visible, or both. These options may be selected from the Alarms me the audible alarm is checked, then a system beep will repeat for as long as the condition remains pres visible alarm will pop up a message box stating the alarm condition.

Communications Menu

The Port option will launch the first screen that shows up when the application starts. Use this optio change the communications port from which SEDL tries to retrieve Super Super Eagle data. Using the AUTOMATIC option will scan COM1: through COM4: to find the Super Super Eagle.

Help Menu

The help menu contains the on-line version of this manual as well as the application about box whic display version information and disclaimer(s).

4. SCANNING

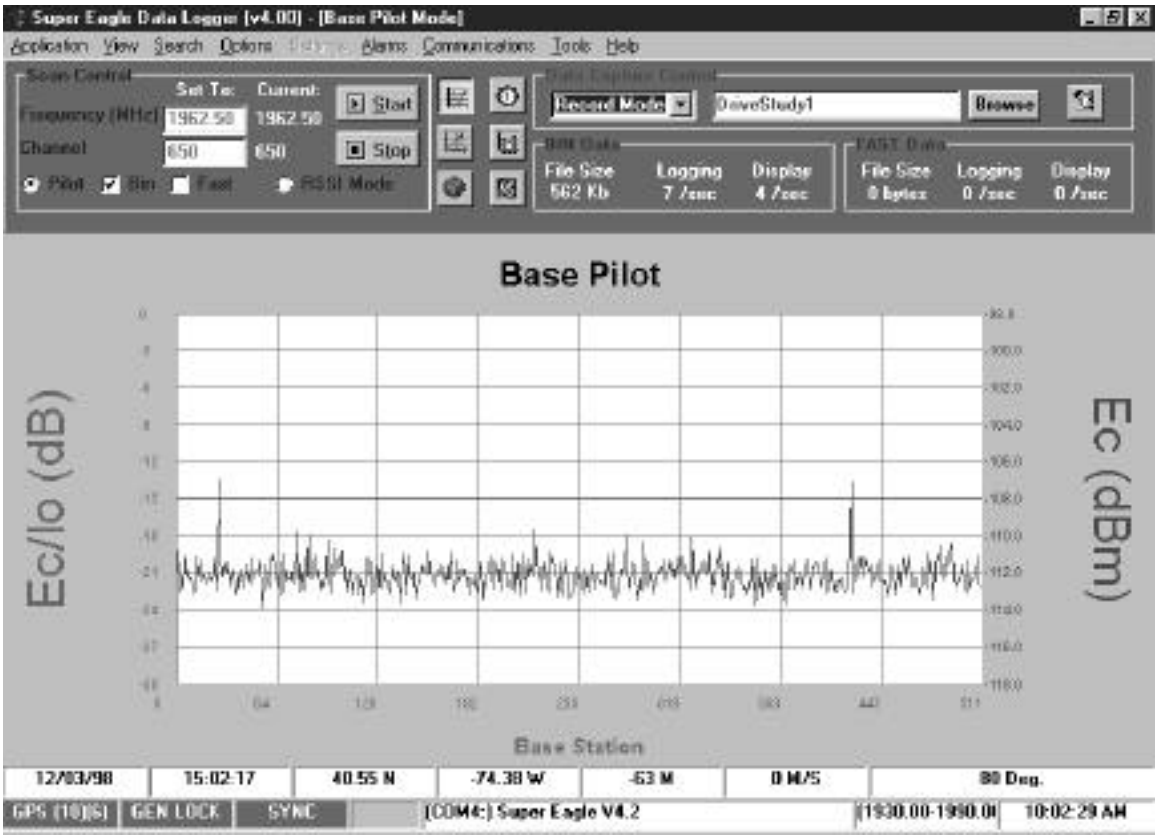


Figure 4

BIN Scanning and Display

When BIN scanning is active, the display will show the entire PN range from 0-65535 (in half-chi Multiple records per second are displayed, as well as logged when logging has been turned on. BIN mo cannot be Zoomed. This display can be shown in Figure 4. The peaks are pilot signals from the strong base stations in the area.

Adjusting the number of averages higher will drop the noise floor of the scan. Lowering the correlati

length will raise the noise floor but will scan noticeably faster. The data that is logged under this mo
shown in the binary file format which is discussed later in this document.

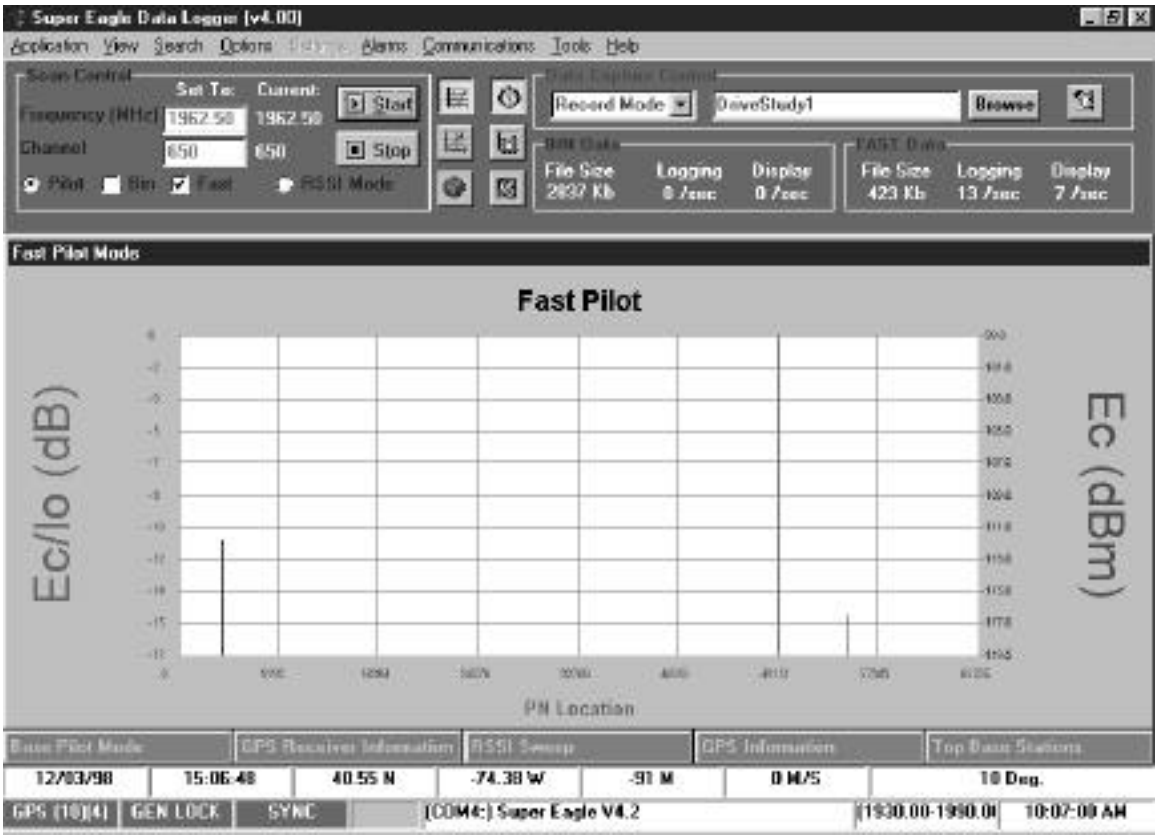


Figure 5

FAST Scanning and Display

When FAST scanning is active, the display will show every point above the threshold at the bottom of grid for the PN range shown (see Figure 5). These records will be reported up to 13 times per secon (with number of averages set to 1) and are ideal for fast fade studies.

The area of interest is changed by using the Zoom feature. To zoom in on a particular range, click the mouse button with the mouse pointer on the center of the desired area. To zoom back out, click on th mouse button.

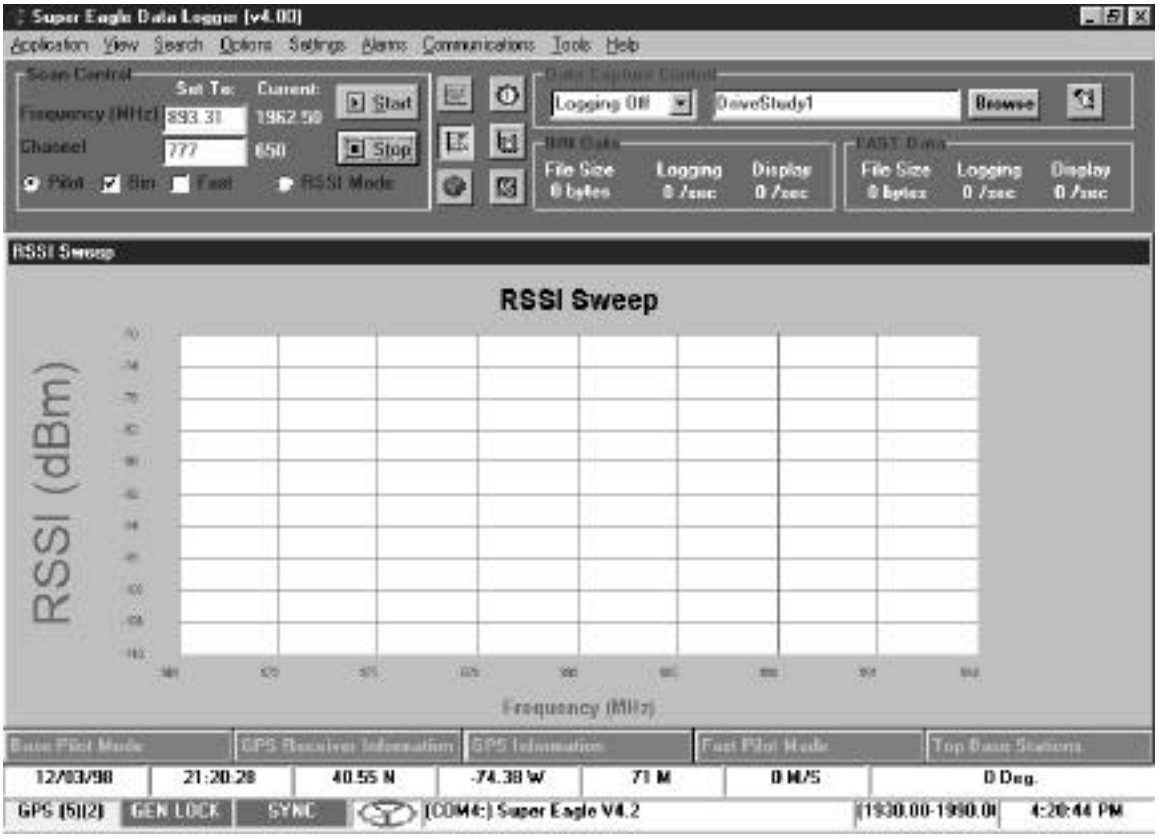


Figure 6

RSSI Scanning and Display

When RSSI mode is started from the control panel, the display plots RSSI (in dBm) versus frequency shown in Figure 6. The entire frequency range of the Super Super Eagle is shown by default. Clicking left mouse button will zoom in on the signal. The mouse pointers location will become the center of tl screen.

Clicking the right mouse button will Pan back out from the Zoomed in view. BIN and FAST Data scanni will be disabled when this mode is activated. Data from RSSI records are not stored in any log files.

Top Base Station Display

The Top Base Station display shows the strongest base stations in the area. They may be ordered in on three ways as discussed earlier. A base station bar will be green if it is above the set TAdd value. It blue if it is between TAdd and TDrop. It will be red if it is weaker than the TDrop value.

If a station is shown in a purple color, this means that it falls outside the reuse factor as determined options. The value on top of the bar is the Ec/Io value of the strongest PN in that base station. The leg under the bar displays the base station number and the half-chip offset (from 0 to 127) of the stron pilot.

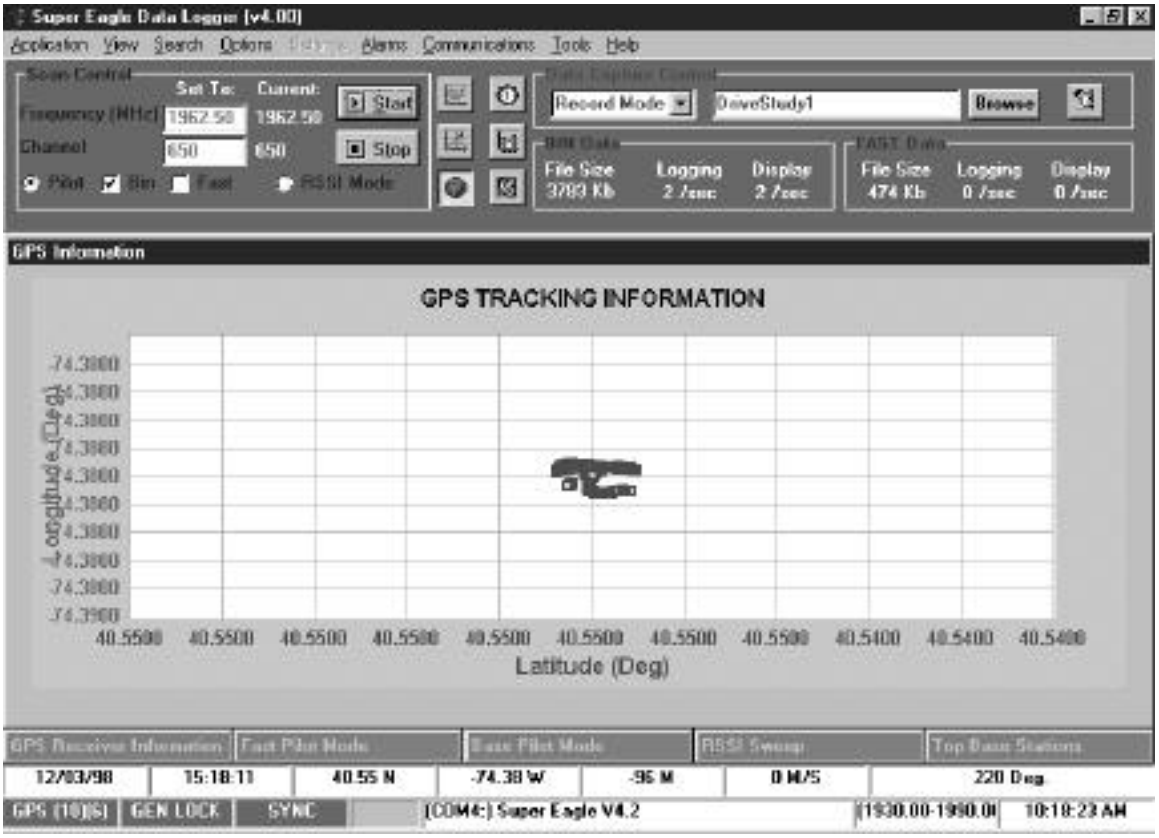


Figure 7

GPS Position Display

The GPS Position display shows the current latitude and longitude in the center of a grid plot of posit points. The current position is always in the center of the screen. Previous points drift away from tl middle of the display. Please see an example of this screen in Figure 7.

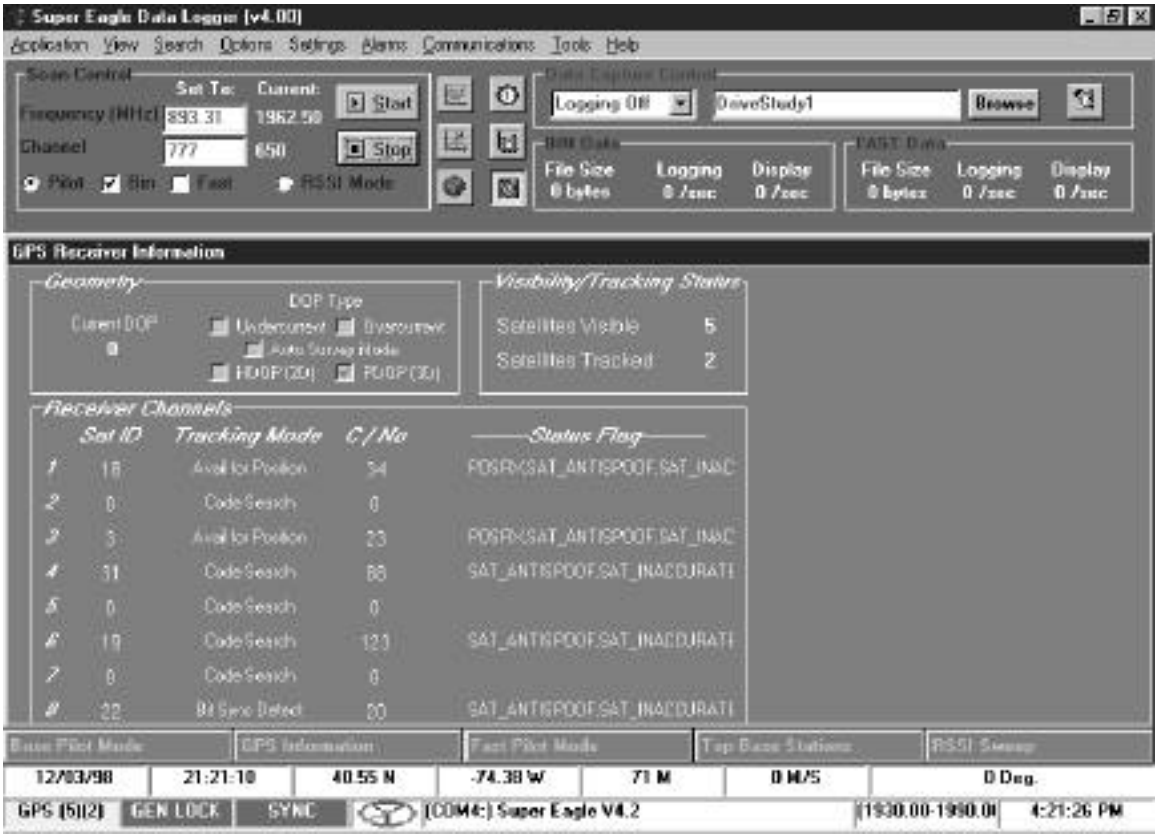


Figure 8

GPS Information Display

The GPS Information screen shows the majority of information bytes from the GPS Receiver in the S Super Eagle. Information, such as tracking status for up to eight satellites and 2D/3D lock status, is updated every second as the new GPS records arrive through the serial port. Please see an example o screen in Figure 8.

Binary File Format

The format of the binary output files reflects the data being received from the Super Super Eagle. Th data are detailed in the low-level command descriptions later in this manual. These include the GPS, and FAST data streams.

Basically, there are five different types of records that are stored in the binary files, depending on t mode that is active. Checksums are the exclusive ORs of all the bytes in the record except for the ini length.

ID record starts each data fileÖ
LLLL I LLLL PPPÖ LLLL VVVÖ CS

Where LLLL is the record length,
I is the record ID,
LLLL is the length of the product string,
PPPÖ is the ASCII product string,
LLLL is the length of the version string,
VVVÖ is the ASCII version string,

CS is the checksum

GPS Record received once per second from the Super Super EagleÖ
LLLL 0x00 GGGÖ CS

Where LLLL is the record length,
0xF0 is the record ID,
GGGÖ is the GPS data record,
CS is the checksum

Parameter Record attached before a GPS record in the fileÖ
LLLL 0xF1 FFFF TT CS

Where LLLL is the record length,
0xF1 is the record ID,
FFFF is the scanner frequency,
TT is the current base threshold (negative value),
CS is the checksum

Data Marker Record inserted every time the user requests a data markerÖ
LLLL 0xF0 MMMÖ CS

Where LLLL is the record length,
0xF0 is the record ID,
MMMÖ is the ASCII marker string,
CS is the checksum

BIN Data Record BIN mode dataÖ
LLLL 0x0E FFFÖ CS

Where LLLL is the record length,
0x0E is the record ID,
FFFÖ is the FAST data record,
CS is the checksum

FAST Data Record FAST mode dataÖ
LLLL 0x04 BBBÖ CS

Where LLLL is the record length,
0x04 is the record ID,
BBBÖ is the BIN data record,
CS is the checksum

Super Super Eagle Commands for V4.0 Firmware

(115.2 k Baud)

Command List

A brief description of all commands.

Command	Value	Description
Get_Version	0x01	Gets Version String
Get_RF_Info	0x02	Get RF Information
Set_Freq	0x03	Sets the Frequency
Start_Pilot_Scan	0x04	Start Pilot Scan Mode
Stop_Pilot_Scan	0x05	Stop Pilot Scan Mode
Find_Peek	0x06	Returns strongest peak
Start_RSSI_Scan	0x07	Start RSSI Mode
Stop_RSSI_Scan	0x08	Stop RSSI Mode
Synch_Setup	0x09	Setup timing parameters
Start_Bin_Scan	0x0E	Start binned PN Scan
Stop_Bin_Scan	0x0F	Stop binned scan
Start_BinZoom_Scan	0x10	Start binned PN scan with parameters
Stop_BinZoom_Scan	0x11	Stop binned PN scan with parameters

Response	Value	Description
Status_Position	0x00	Returns Status and Position
Version_Info	0x01	Response to Get_Version
RF_Info	0x02	Response to Get_RF_Info
Pilot_Scan	0x04	Pilot Scan Data
Peak_Scan	0x06	Peak Scan Data
RSSI_Scan	0x07	RSSI Data
Bin_Scan	0x0E	Bin Data
BinZoom_Scan	0x11	BinZoom Data

Note: The Response has the same number as the command that issued it. All commands responces not specifically listed have the default response, detailed the text.

Conventions

The following conventions are used throughout this document:

< X> = X is a Byte Value
[X] = X is a Word Value
{ } n = the expression in the braces is repeated n times.
(X) = The size of X is variable.
[[X]] = X is a four byte Value.

Command Format

All commands are sent (and all responses are received) in the following format

<0xAA>[Length of Packet](Command and Parameters)<Check Sum>

The Length of the Packet is the number of bytes in Command and Parameters pl
the checksum.

Command Descriptions

Get_Version
format:
<Get_Version>
Description:
Returns the Version String. See response Version_Info.

Response:
Version_Info

Get_RF_Info
format:
<Get_RF_Info>
Description:
Returns the parameters necesarry to set the frequency. Se response RF_I

Response:
RF_Info

Set_Freq
Format:
<Set_Freq> [[Frequency]]
Description:
Sets the center frequency for pilot scanning. The Frequency is a four byte

value equal to the actual RF frequency divided by the StepSize (from the RF_In response).

Response:
Default response.

Start_Pilot_Scan
Format:
<Start_Pilot_Scan> <Number of Averages code>[Threshold]
Description:
Start the pilot scan Mode. Pilot scan packets are returned until a Stop_Pilot_Scan command is sent. The correlation length of 1024 is averaged t number of times given in the table bellow.

Code Value	Number of Averages
1	1
2	4
4	8
8	16

The Threshold is in quarter dB. Example : for a threshold of 18, -72 is sent.
Response:
Pilot_Scan

Stop_Pilot_Scan
Format:
<Stop_Pilot_Scan>
Description:
Ends pilot scan mode.
Response:
Default Response.

Find_Peak
Format:
<Find Peak> <Number of Averages Code>
Description:
Starts a peak search, which returns the location and strength of the strongest pilot. Only one scan is performed. See Start_Pilot_Scan for definit of Number of Averages Code.

Response:

Peak_Scan

Start_RSSI_Scan
Format:

<Start_RSSI_Scan> [[Start Frequency]] [Step] [Count]
Description:

Returns consecutive RSSI Sweeps. The Start Frequency is a four byte num in the same units and the Set_Freq command. The Step gives the frequnecy increment between points (in the same units as the Start Frequency). Count is number of Steps to return.

Response:

RSSI_Scan

Stop_RSSI_Scan
Format:

<Stop_RSSI_Scan>
Description:

Ends RSSI Scan Mode.
Response:

Default response.

Synch_Setup
Format:

<Synch_Setup> <Int/Ext Synch> [Genlock Reset Delay]
Description:

Int/Ext equals 1 when the clock sources are external (BVS Rhino) and 0 wh the synchronization is taken for the internal GPS and Genlock circuitry. The Genlock Reset Delay allows the user to pick the duration (in seconds) that GPS can be lost before the Genlock circuitry is reset. This allows for brief outages GPS.

Start_Bin_Scan
Format:

<Start_Bin_Scan> <Number of Averages>
Description:

Returns the maximum in each base station PN range. See Start_Pilot_Scan for a description of Number of Averages.
Response:

Bin_Scan

Stop_Bin_Scan
Format:
<Stop_Bin_Scan>
Description:
Stops the Bin_Scan mode.
Response:
Default response.

Start_BinZoom_Scan
Format:
<Start_BinZoom_Scan> <Number of Averages> [Base] <Bin Size> [Number of Points]
Description:
Returns the maximum in each base station PN range. Base is the base stat offfset to start at. Bin Size is in half chips. Number of points is the total nu of points returned. See Start_Pilot_Scan for a description of Number of Averag
Response:
BinZoom_Scan

Stop_BinZoom_Scan
Format:
<Stop_BinZoom_Scan>
Description:
Stops the BinZoom_Scan mode.
Response:
Default response.

Responses

Default Response
Format:
<Command Number> <Error Code>
Description:
The is the general response format for any command that does not have a special response. The Command Number is the ID of the command that the resp if for. Error code equal zero if there is no error.

Status_Position
Format:

<Status_Position>[Status][Mode Flags] [[Actual Frequency]] <Number of Averages> [GPS Reset Delay] (70 bytes of GPS Data)

Description:

This packet is sent once per second when the GPS data is updated. The sta byte contains several flags.

bit	Meaning	
0	GPS Lock	This is "1" when the system has GPS Lock
1	GenLocked	This is "1" when the system is GenLocked.
2	Synched	This is "1" when the system is synchronized to the even second of GPS time.
3	External	This is 1 when the system is running from external clocks (BVS Rhino).

The Mode Flags word has the following bits defined:

Bit	Meaning
0	Pilot Scan In Progress
1	Peak Scan In Progress
2	RSSI Scan In Progress
3	Bin Scan In Progress
4	Bin Zoom in Progress

Version_Info

Format:

<Version_Info>(Version String)

Description:

The version string is a null terminated ASCII String that contains the ver information.

RF_Info

Format:

<RF_Info> [Min RF Low] [Min RF High] [Max RF Low] [Max RF High] [Stepsize]

Description:

The Min RF frequency and the Max RF frequency are two word integers expressed in kilohertz. The Stepsize is in kilohertz and is a one word value.

Pilot_Scan

Format:

<Pilot_Scan>[i Factor][i Factor] [Frame Number]{[PN location] [Power]}x100

Description:
The two factors are signed 16 bit numbers that are used to calculate Ec/Io and true power, P, from the correlation counts, Nc. These values are determined in dB (or dBm for true power) as follows:

$$P = 20\log(Nc) + Si$$
$$Ec/Io = 20\log(Nc) + Ei$$

The frame number is the frame count since the start of the even second mark. frames are between 0 and 74.

The data is returned in word pairs, as follows.

<PN Location><Power>

The PN location is in half chips. The Power is in Correlation counts and can be converted to Ec/Io or true power. The end of data is marked by a Power value of zero (the PN Location will also be set equal to zero). Although the length of the valid data varries, the packet is always the same size.

Peak_Scan
Format:
<Peak_Scan>[Si Factor][Ei Factor] [PN Location][Power]
Description:
A single Peak_Scan packet is returned for each Find_Peak command. The parameters are the same as Pilot_Scan.

RSSI_Scan
Format:
<RSSI_Scan> [[Frequency]] [Step] <Number of Measurements> {[RSSI Data]}Numbe
Mesurements
Description:
Each data word contains the RSSI value (in dB) for the frequenc
step.

Bin_Scan
Format:
<Bin_Scan>[Si Factor] [EI Factor] [Frame #] {[Power]<Half Chip Offset>}51
Description:
Returns power for each base station range. See Pilot_Scan for
definition of data items.

BinZoom_Scan
Format:
<Bin_Scan>{i Factor]{i Factor] [Frame #] [Base] <Bin Size> [Number of Points] {[Power] }xNumberOfPoints
Description:
Returns power for each base station range. See Pilot_Scan for definition of data items.

Guidelines for direct software interface to the Super Eagle receiver

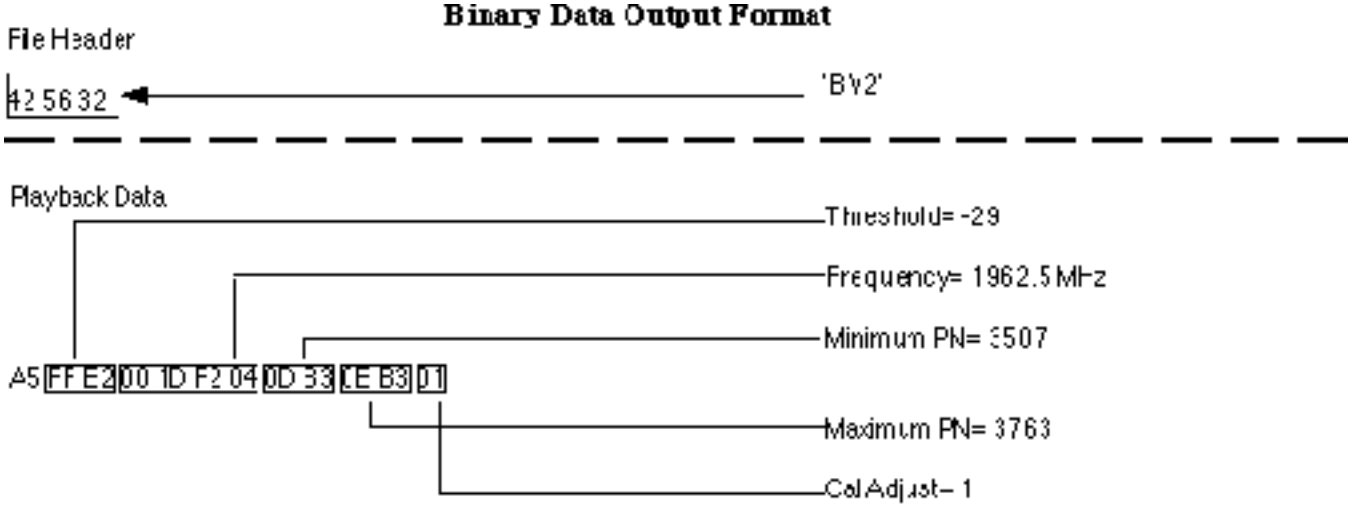
By writing software, the end user can directly issue low level commands to the Super Eagle receiver via an RS232 serial port. The ability to directly control the Super Eagle provides user with the ability to perform specialized tests and automated testing.

The primary purpose of the Super Eagle is to scan PN phase offsets and report correlated power for those offsets. An IS-95 base station produces a PN pilot code that is 215 chips long. There are, therefore, 32768 different PN offsets. The Super Eagle samples twice per chip, so there are 65536 locations that are scanned by the Super Eagle. All references to PN locations refer to a number between 0 and 65535 (representing PN position in half chips).

For each scan, the Super Eagle calculates all 65536 locations, processes the data, and returns the requested information to the controlling device (usually a PC). The scan time is one IS-95 pilot frame (the period of the pilot code), which is approximately 27 ms. All searches defined by the user are then performed, and the data for each search is returned to

Binary Data Output Format

File Header



Super Eagle Q & A

While the Super Super Eagle and the accompanying Hawkeye software represent the simplest of hardware and software interfaces, CDMA technology is a technically complicated science. In response to a variety of questions, Dr. James Bush has prepared this brief summary:

The apparent level of the Ec/Io noise floor is a function of received pilot strength, if a signal is present. The IS-95 pilot code is a very long PN sequence. When correlating against this code across even a fairly large subsection of this code, there is a correlation noise floor. In the Super Eagle, which uses a 256 chip correlation length, this value is 15 dB down from inphase correlation. What this means is that Ec/Io measurement has a noise floor that is about 15 dB down from the pilot Ec/Io. Suppose an active base station has a pilot Ec/Io of -9 dB, then the noise floor at that moment would be -24 dB. If on the other hand, no signal is present, the gain in the Super Eagle increases until the noise is brought to full scale. Uncorrelated noise does have a small gain through a correlator, in the Super Eagle this produces an Ec/Io noise floor of -7 dB (the true correlated power for these "peaks" will be very low). This high noise floor, of course, is due to the high sensitivity of the Super Eagle receiver.

It is important to remember that the Ec/Io of a signal is unrelated to the signal strength, in so much as without interferers, the Ec/Io of a base station would remain constant regardless of signal level until the thermal noise floor was approached (just below -100 dBm). The Super Eagle can receive pilot signals with signal strengths well below -100 dBm. However, a much stronger base station will cover a weak signal (see previous paragraph). These signals will also be hidden to a CDMA telephone and all CDMA sounding equipment. When close to a base station, a CDMA phone only knows who the neighboring cells are, because it is told by the base station (it cannot hand-off to them at this point since it cannot "see" them). A neighbor list must be built by examining the fringe areas of a cell that do permit hand-offs.

Often, when using an Super Eagle, other momentary peaks bounce around the peak corresponding to a base station. These peaks are not noise but really exist and are most likely multipath reflections from moving objects. The presence of such peaks tell you a great deal about CDMA environments. If the user is interested in integrating these peaks out, this can be done in post-processing. Also, the VGA screen is updated slowly as compared to the rate of captured and recorded data. I hope this eliminates some of the confusion as to the interpretation of the Super Eagle CDMA sounder's measurements.

The following are some of the more common questions that the BVS technical support staff receives:

Questions

1. What is the minimum Ec/Io that can be measured?

2. Can a user calibrate the Super Eagle without assistance from Berkeley?

3. What is the Super Eagle's RF sensitivity?

4. What is the processing gain and how does BVS compute it?

5. How is the output format of Super Eagle compatible to various post-processing packages?

Answers

1. The Min Ec/Io specified in the table above is based on processing gain. The weakest to strongest values were produced by computer simulation.

2. It is not advisable for an Super Eagle user to attempt calibration by themselves. This is because the HP 8924C is really a base station simulator and has a rather inaccurate power control, limited to -30 dBm because it was not intended to accurately measure or control power, just to simulate a high-level radiated signal. More importantly, it would be an "apples to oranges" calibration, since the HP and even the Tektronix / Rodie base station simulators include all CDMA channels, and not just Pilot, as in the Super Eagle. The Rodie / Tektronix CDMA unit is much more accurate and extends 18 dB further, but still not advisable.
The calibration process of an Super Eagle is rather tedious and extensive. We are automating it here but it still is too complex to detail to customers. It requires some hardware fixtures and can be treacherous because the calibration tables must be exact or the unit will be way off. The process itself uses a calibrated CDMA source (right now an HP-4000A signal generator externally modulated or a Duet PN) and fed into a series of automated step attenuators.
BVS provides free calibration to all of our Super Eagles customers that are within the warrantee period of 180 days. The process takes one day and serves as a quick "RF sanity check" for the Super Eagle when compared to a good spectrum analyzer such as an HP 8563 or equivalent.

3. The receiver has an RF sensitivity down to approximately -95 dBm. This is the point at which the AGC stops responding to decreases in RF level.

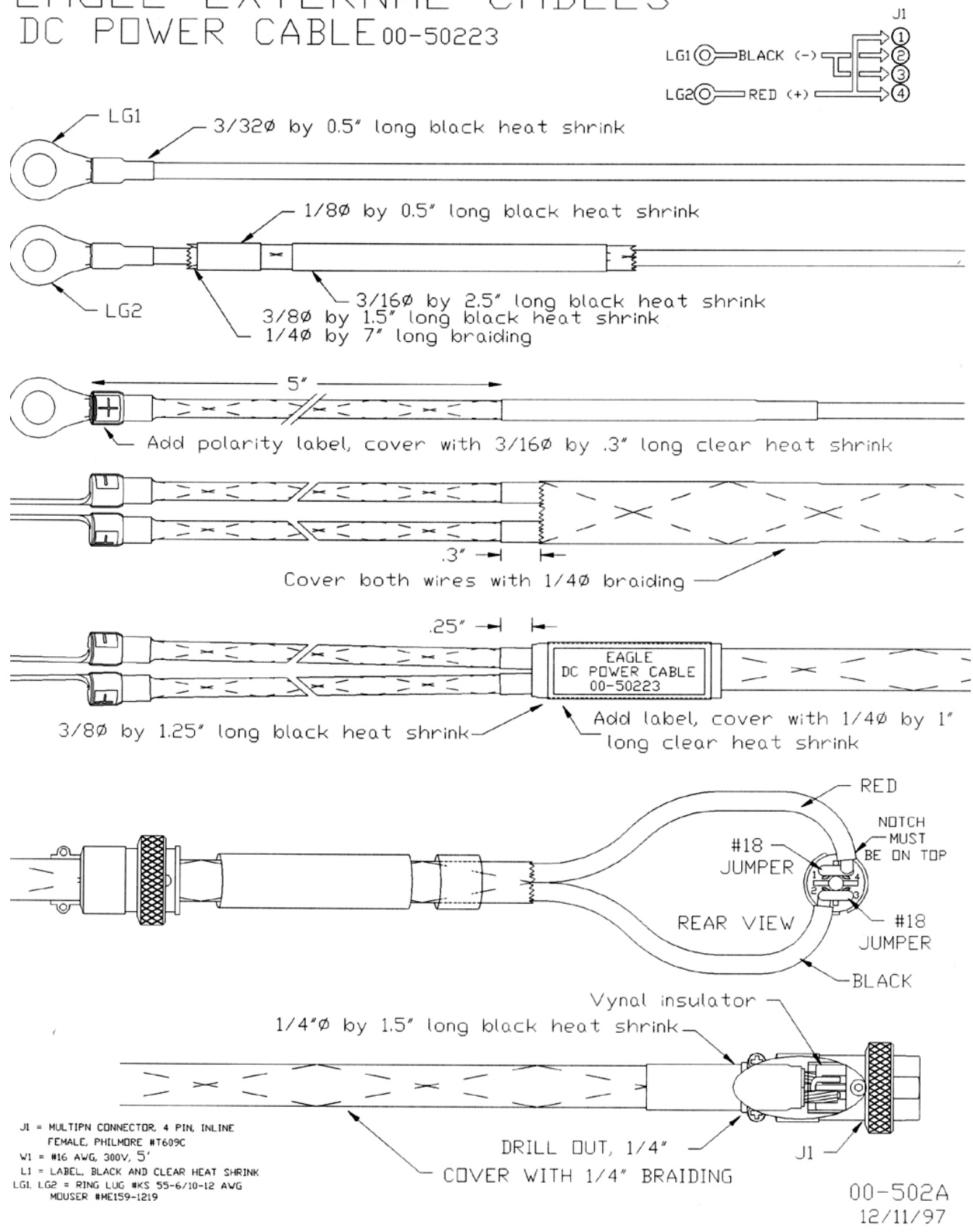
4. The pilot correlation length is 256 chips. The gain of the signal is through this process is 20 log(256)=48 dB. However, the gain through the correlator for Gaussian noise would be 10 log(256)=24 dB. Therefore, the processing gain above Gaussian noise is 24 dB.
It should be noted that this cannot be used to determine the maximum difference between strongest and weakest base stations that can be measured simultaneously. The real limitation is the correlation noise floor. Correlating across the IS-95 PN code with a correlation length of 256 chips, the maximum non-aligned correlation is -15 dB down from the aligned value. Base stations 15 dB below the strongest base station will be hidden in the correlation noise of the stronger PN. It is important to realize that this property of short correlations on very long PN codes. All IS-95 phones and test equipment suffer the same limitation.

5. This is handled most simply by Berkeley's Chameleon data translation software package. This application can run on any PC and supports the following output formats:

Comarco Workbench
EDX SignalPro
Expert Wireless MaXPlan
Generic ASCII
Grayson IQ Analyzer
MapInfo (w/dB Planner)
Microsoft Excel
MLJ PathPro
MSI Planet
SafCo OPAS32
TEC Cellular Wizard
Teleworx PlotworX

EAGLE EXTERNAL CABLES

DC POWER CABLE 00-50223

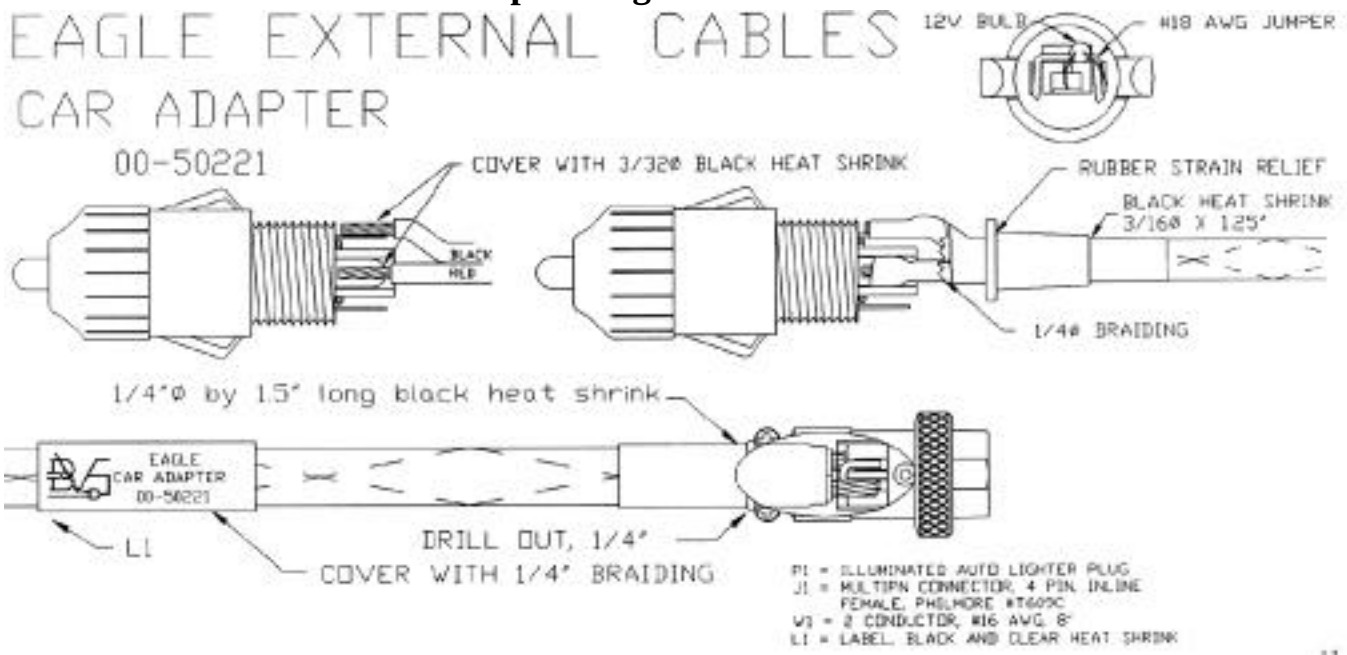


J1 = MULTIPN CONNECTOR, 4 PIN, INLINE
FEMALE, PHILMORE #T609C
W1 = #16 AWG, 300V, 5'
L1 = LABEL, BLACK AND CLEAR HEAT SHRINK
LG1, LG2 = RING LUG #KS 55-6/10-12 AWG
MOUSER #ME159-1219

00-502A
12/11/97

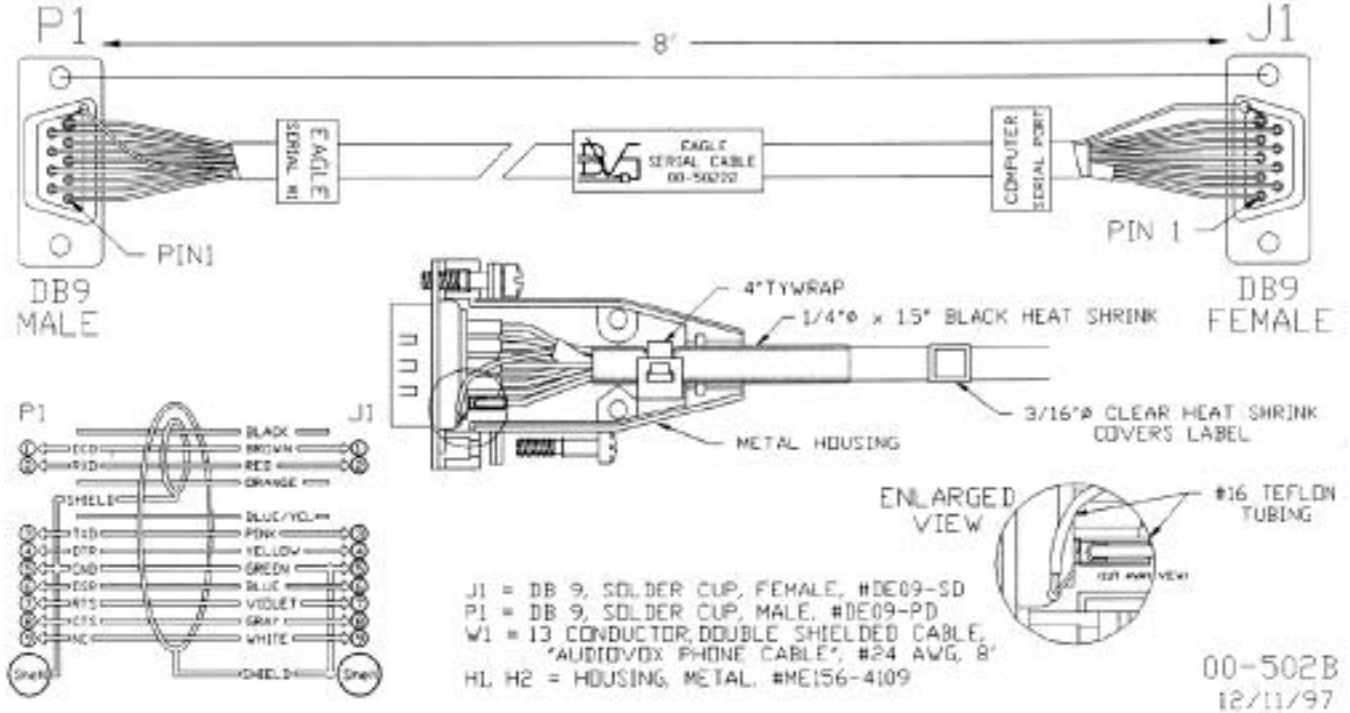
EAGLE EXTERNAL CABLES

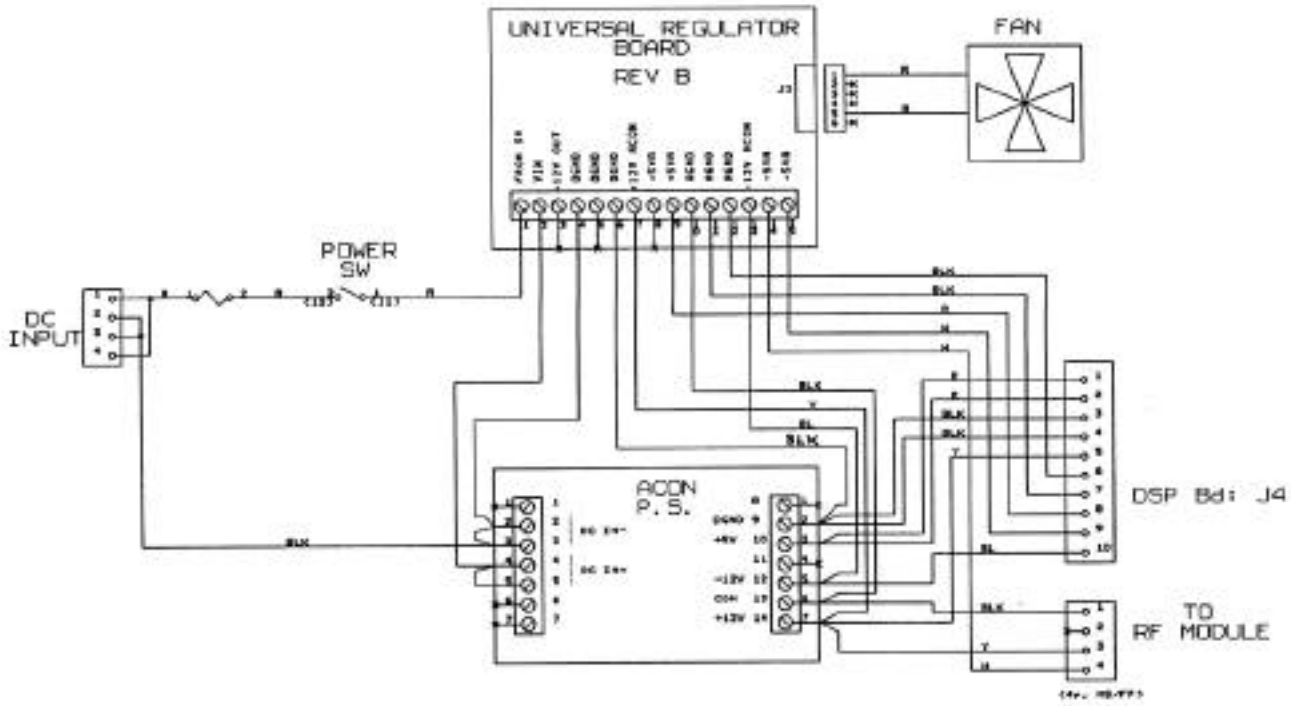
CAR ADAPTER



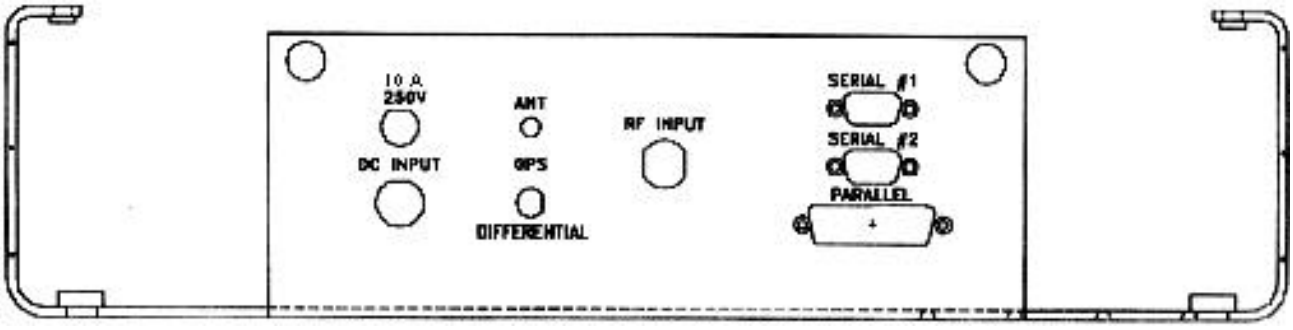
SERIAL CABLE

00-50222

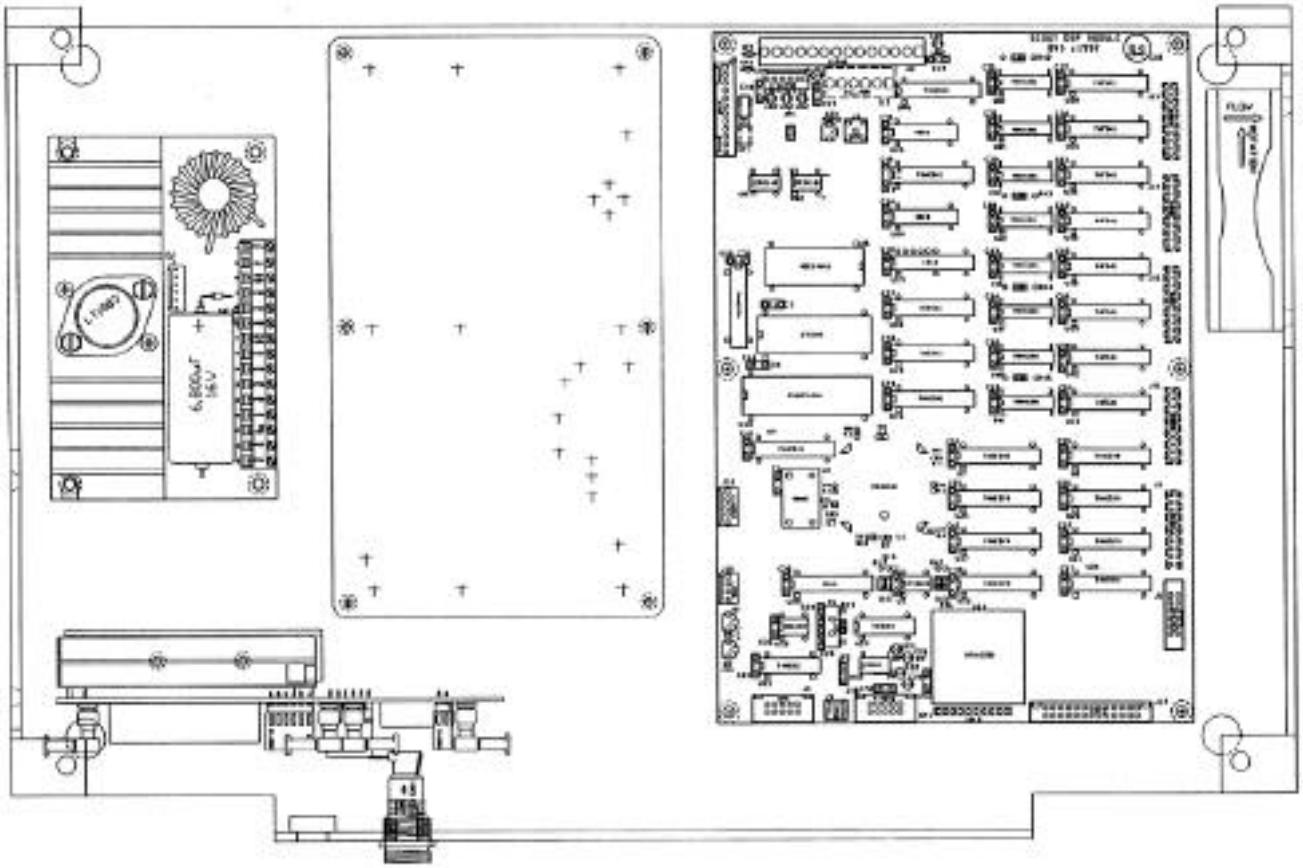




Super Eagle/Super Super Eagle Universal Regulator Board



Super Eagle/Super Super Eagle Back Panel



Super Eagle/Super Super Eagle Layout (top view)

SPECIFICATIONS for laptop PC as provided with Super Super Eagle

CPU, Memory, and Architecture:

Intel Pentium(r) processor: 233mhz MMX or 166mhz. Supplies correct dual voltages for MMX processors. 128MB maximum EDO RAM. PCI Bus architecture. 256K Level 2 Synchronous Pipelined burst-mode Cache.

Display:

12.1" 800 x 600 Dual-Scan Passive (256 color) or TFT Active Matrix Color display supporting 480,000 simultaneous colors from a 16 million color pallet. Trident video chip features 2MB EDO display memory, acceleration, and a 64-bit PCI Bus interface, and supports simultaneous display on LCD (internal) and external VGA or NTSC/PAL monitor or TV/VCR. Up to 1280 x 1024 resolution in 256 colors when used with external monitor. Internal MPEG available.

Input Devices:

PS/2 Glidepad (centered under keyboard). 86-key detachable Win95 keyboard with A4 size keys and an embedded numeric keypad.

Ports:

1 DB9 serial (high-speed 16550 UART) and 1 parallel (EPP/ECP) port. External VGA, microphone, speaker, keyboard/mouse (ps/2), game/MIDI, and infrared file transfer (IrDA / FIR compliant) ports.

Integrated Multimedia:

Built-in CD-ROM Drive, using an IDE interface for best compatibility. Internal 16-bit Soundblaster Pro 3.01 compatible sound card with 1MB ROM wavetable for high quality sounds. Built-in mic and stereo speakers.

PCMCIA:

Two stacked PCMCIA type II expansion slots (these also accept one type III card in the place of 2 type II cards).

PLUS one additional, separate type II only slot with support for Zoomed Video (a direct bus to the video display).

Physical:

11.8" x 8.9" x 2". Weighs 7.5 lbs. with one battery and floppy in place.

Power:

110V - 240V, 47-63hz auto-sensing external AC adapter. Built-in Intelligent Power Management (IPM) hardware. Removable lithium ion battery. Primary battery alone lasts 1 to 1.3 hours depending on use. Primary and secondary battery used together last 2 to 2.6 hours depending on use. (Suspend feature further extends battery life when system is idle). Suspend to hard disk feature saves all memory to the hard drive before a low battery condition shutdown occurs.

Removable drives:

1.3GB (13ms) or 2.1GB (12ms) hard drive options. Enhanced PCI IDE hard disk interface supports PIO mode 3 operation. 3.5" 1.44MB Floppy Diskette Drive (removes for insertion of second battery).

110 Watt internal power supply, accepts 100-240V AC power in. One 5.25" and one 3/5" drive bay (SCSI devices recommended). One special bay accepts the 6200/mint floppy drive. Three PCI slots accept two-thirds height PCI cards. One parallel port, two serial ports, one 15-pin VGA/SVGA port, one external ps/2 keyboard/mouse port, headphone jack, TV out RCA jack, one game/midi port. Two internal speakers. Dimensions: 381mm x 405.5mm x 113mm. Weight: 2.5kg (5.5lbs).

Glossary of Acronyms

AC	Alternating Current
A/D	Analog to Digital converter
AGC	Automatic Gain Control
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BW	Band Width
CDMA	Code Division Multiple Access (spread spectrum modulation)
DC	Direct Current
D/A	Digital to Analog
dB	decibel
dBm	decibels referenced to 1 milliwatt
DOS	Digital Operating System
DSP	Digital Signal Processing
FIR	Finite Impulse Response
GHz	GigaHertz
GPS	Global Positioning System (satellite based)
GPS diff.	GPS error correction signal which enhances GPS accuracy
IF	intermediate frequency
I and Q	In phase and Quadrature
kHz	kiloHertz
LCD	Liquid Crystal Display
LO	Local Oscillator
Mbits	Megabits
MHz	MegaHertz
modem	modulator/demodulator
PCMCIA	Personal Computer Memory Card International Association
PC	Personal Computer
PCS	Personal Communications Service (1.8 to 2.1 GHz)
PN	Pseudo Noise
QPSK	Quaternary Phase Shift Keying, 4-level PSK
RF	Radio Frequency
RSSI	Receiver Signal Strength Indicator
UCT	Universal Coordinated Time
VAC	Volts Alternating Current
VGA	video graphic

Technical Support

- Up-to-date information is available on our web site at **http://www.bvsystems.com**
- The latest version of Hawkeye is also available on our web site for download..
- If you wish to contact technical support, mail to **info@bvsystems.com**

Acknowledgements

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- Windows is a trademark of Microsoft Corporation.

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